

Section 960

GUIDELINES FOR SUPERPAVE VOLUMETRIC MIX DESIGN AND VERIFICATION**960.01 Scope**

This procedure provides guidelines to determine a Superpave Volumetric Mix Design for Department projects. The Contractor will perform and submit the mix design according to specification; the Department will verify the mix design.

REFERENCES:**AASHTO STANDARDS:**

T 312 Standard Method for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

R 30 Standard Practice for Mixture Conditioning of Hot-Mix Asphalt (HMA)

AASHTO PROVISIONAL STANDARDS:

MP 2 Superpave Volumetric Mix Design

PP 28 Standard Practice for Superpave Volumetric Design for Hot Mix Asphalt (HMA)

UDOT MANUAL OF INSTRUCTION PART 8

UDOT MINIMUM SAMPLING AND TESTING GUIDE

UDOT STANDARD SPECIFICATIONS

UDOT PROJECT SPECIAL PROVISIONS

960.02 Superpave Volumetric Mix Design Guidelines

The mix design shall comply with MP 2 Superpave Volumetric Mix Design with the following modification:

Binder, aggregate and mix properties are to be defined by project specification, including, but not limited to: dust-to-binder ratio, VMA, VFA and design air void content (V_a).

Use a laboratory qualified in HMA by the UDOT Laboratory Qualification Program.

Use UDOT Manual of Instruction Part 8-961: Guidelines for Superpave Gyratory Compactor Protocol approved compactor.

960.03 Mix Design Process

Perform mix design in accordance with AASHTO PP 28: Superpave Volumetric Design for Hot-Mix Asphalt with the following modifications:

In Section 9 replace G_{sb} with $G_{sb}SSD$ in every occurrence.

Target air void content (V_a) shall be by project specification.

The asphalt binder used in the design shall be obtained from a certified supplier meeting the requirements outlined in UDOT Minimum Sampling and Testing Guide Quality Management Plan 509: Asphalt Binder Management System. The binder shall be accompanied by test results or pre-tested by the Central Materials Asphalt Laboratory prior to use in the design. Mixing and compaction temperatures for the mix design must be obtained from the Engineer.

The hydrated lime used in the design shall be obtained from a certified supplier meeting the requirements outlined in UDOT Minimum Sampling and Testing Guide Quality Management Plan 510: Hydrated Lime Management System. The hydrated lime shall be accompanied by test results or pre-tested by the Central Materials Laboratory prior to use in the design.

Mixed material will be short term aged at compaction temperature for 2 hours for absorptions of 2.5% or less. High absorption aggregate ($>2.5\%$) will be short term aged for 4 hours (AASHTO R 30).

After the design parameters are determined, prepare and compact 4 sets of 2 Gyratory specimens. Compact 3 sets to N_{design} to verify the optimum asphalt binder content and other design requirements. Compact 1 set to N_{max} to verify required relative density.

After the design is completed, submit pre-mixed material to the Central Materials Laboratory for testing as per UDOT Manual of Instruction Part 8-990 Method of Test for Hamburg Wheel Track Testing.

960.03.01 Mix Design Report

Submit Mix Design Report to the Region Materials Engineer. Submit Mix Design Report Summary and Transmittal Letter to the Project Engineer. Follow the outline and example in Appendix "A" and include all test data obtained during the design process.

960.03.02 UDOT's Mix Design Verification Process**General:**

The mix design verification process outlined in this document is intended to be complete. However, verification could include any or all tests identified in AASHTO MP 2, project specifications, project special provisions, the current UDOT Manual of Instruction Part 8, the current UDOT Minimum Sampling and Testing Guide or other aggregate quality, volumetric, or mix performance tests that may be added in the future

Specifications identify the period of time allotted for mix design verification in terms of “working days.” “Working days” refer to Monday through Friday, excluding state holidays, and begin when the following are submitted to the Region Laboratory:

- *All* aggregate quality test results
- *All* aggregate samples for quality verification tests (one bag, 50 - 80 lb, of aggregate from each stockpile used)
- *All* pre-blended aggregate samples.
- A *sufficient quantity* of the asphalt binder used during the mix design process.
- A *sufficient quantity* of the lime used during the mix design process.

“Working days” end when the Region Materials Engineer provides an answer of “Verified as submitted,” “Verified with conditions,” or “Not Verified for the following reasons.”

Verification of testing results by the Region can be achieved either through proper testing procedures, by source history or field verification.

The verified mix design will be valid for the life of the project or two years. After two years, re-verification of the volumetric mix design is required.

A mix design achieving verification in any Region may be submitted for verification in another Region. Submit requests through the Materials and Resident Engineers of that Region; include any project documentation regarding field changes made after verification.

Contractor Sample Submittals

Pre-Blended Samples: UDOT’s verification results will be determined from tests of pre-blended samples prepared and submitted by the Contractor to the Region Materials Engineer. A pre-blended sample is a blend of the final aggregate structure, without lime and binder. The lime and binder are submitted separately. Individual pre-blended samples are required; larger samples split to sample size are not acceptable. Samples will be made by recombining each individual sieve to meet sample size. Lime is considered a separate “stockpile.” The final gradation of the pre-blended samples will be determined after lime induction as per specification. If the gradation with the lime does not meet the target values within the tolerances shown, the submitted samples are determined to be unacceptable by the Region Materials Engineer, the supplier shall submit new samples and the verification process shall restart.

The following tolerances from target gradation for each sieve will be allowed:

1/2 inch	2%
3/8 inch	2%
No. 4	2%
No. 8	1%
No. 16	1%
No. 30	1%
No. 50	1%
No. 100	1%
No. 200	0.8%

13 Samples - Gyratory Compaction Size

- 4 sets of 2 samples for gyratory specimens to verify design requirements.
- 1 sample will be for Department use.
- 4 samples for aggregate quality tests.

4 Samples for G_{mm} Determination - AASHTO T 209

10 Samples for Ignition Oven Calibrations - AASHTO T 308

- For Region and Project ignition oven calibrations to be submitted after mix design has been verified and prior to project production. Prepared as above.

Recommended Testing Precision Criteria:

The following testing precision criteria are recommended as a guide and should be used as a tool to improve the verification process:

<u>Testing Subject</u>	<u>Precision</u>
T 84 - Specific Gravity and Absorption of Fine Aggregate (G_{sbSSD})	0.027
T 85 - Specific Gravity and Absorption of Coarse Aggregate (G_{sbSSD})	0.020
T 166 - Bulk Specific Gravity of Compacted Bituminous Mixtures	0.020
T 209 - Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures	0.012
Gyratory Specimen Heights for Design (Average)	5mm
Gyratory Specimen Heights for UDOT Verification (Average)	3mm

Mix Design Verification Criteria:

Air Voids: Air voids in the mix shall be the final verification criterion. The air voids at N_{design} must fall between 3.0% and 4.0%. If specification requirements or the N_{design} air voids criterion is not met, the verification process will stop until discrepancies have been resolved. When the verification process stops for these reasons, the “working days” allotted by specification will be suspended and will

not begin again until the discrepancy has been resolved. At no time will the Materials Engineer allow UDOT's testing results to be used in any of the submitting entity's volumetric calculations.

Asphalt Binder: The selected asphalt binder shall meet specified project requirements.

Design Gyrations: The design gyrations selected for N_{ini} , N_{des} and N_{max} shall meet project specification.

Gradation:

- The gradation will be analyzed and verified for compliance with the specifications.
- The stockpile gradations and blending percentages must be submitted and may be verified by the Region and compared to the submitted data.

The following will be evaluated and may be verified on the samples as submitted to determine compliance with the specifications:

Volumetric Design Criteria

- **VMA** – VMA at N_{design} using G_{sbSSD} (AASHTO PP 28, section 9.2).
- **Dust Proportion**
- **Hamburg Wheel Track Testing** – Tested in accordance with UDOT Materials Manual of Instruction Part 8-990 Hamburg Wheel Track Testing of Compacted Bituminous Mixtures.

VFA

Hydrated Lime - The submitted lime percentage shall meet project specification and design requirements. Initial plant inspection will be performed to verify lime slurry capabilities. The added lime shall be verified to be included as part of the aggregate structure in all calculations.

Gyratory Specimen Heights - The submitted Gyratory Specimen Heights shall fall within Superpave guidelines of $115 \pm 5\text{mm}$ for design and recommended UDOT guidelines of $115 \pm 2\text{mm}$ for verification.

Air Voids - The target air voids shall be verified at N_{des} .

Aggregate Quality Tests - The submitted aggregate quality tests shall be reviewed for compliance with project specification criteria. UDOT Region Laboratory may verify any or all quality tests.

Any or all of the quality verification tests may be revisited during production. If any of the aggregate quality tests do not meet the specified criteria, production shall be halted and the issue addressed.

Mandatory Dispute Resolution Tests:

AASHTO T 84 & T 85, (*SSD method*) - G_{sbSSD} , fine and coarse aggregate specific gravities and absorptions

AASHTO T 209 - G_{mm} , theoretical maximum specific gravity

AASHTO T 166 - G_{mb} , bulk specific gravity of compacted mix

960.03.03 Field Mix Design Verification:

The Region Materials Engineer may allow a field verification option of the mix design for a supplier with a multi year history of supplying specification HMA. Region Lab performs field verification from samples taken in accordance with UDOT Manual of Instruction Part 8-984, and reduced in accordance with UDOT Manual of Instruction Part 8-985, from material placed on the project or an independent test strip. If material is placed on the project, production is limited to a 2 hour run at the plant's intended project production rate, not to exceed 500 Tons.

Verification will consist of three samples; each sample will be used to prepare two specimens. Two sets of specimens will be compacted to N_{design} to verify the asphalt content and other design requirements. The third set will be compacted to N_{max} to verify required relative density. Should the mix from the first attempt at field verification not meet the required properties as outlined above, the supplier will make adjustments and the field verification process will be repeated. Should the second attempt at field verification fail, the mix design is "Not Verified" and a new mix design is required. Any mix placed that is not approved through the verification process will be removed at the contractor's expense.

960.03.04 UDOT's Mix Design Review Report

After reviewing the mix design report and performing verification testing, the Region Materials Engineer will provide a written summary report to the Project Engineer as notification of verification results. This Mix Design Review Report will state the verification results as either "Verified as submitted," "Verified with the following conditions," or "Not Verified for the following reasons," and will contain a summary of verification test results and needed construction information. Appendix "B" shows an example of information contained in the Mix Design Review Report. Only the Region Materials Engineer may supply the Mix Design Review Report.

960.03.05 Volumetric Mix Design Dispute Resolution

If a mix design does not initially verify, all mandatory tests identified are to be performed, compared and used in the "Dispute Resolution" process. These tests results are to resolve any discrepancies between the Region and the Contractor's Consultant laboratories. If the mix design still does not verify, the focus of the volumetric mix design dispute resolution will be on the volumetric mix properties, the appropriate calculations and relationships, and tests identified as "**Mandatory Dispute Resolution**"

Tests.” The testing precision will be analyzed and the tests may be re-run by both parties involved.

Field Volumetric Mix Design Verification for Dispute Resolution:

If testing discrepancies and volumetric resolutions cannot be achieved with the above lab verification process, the Region Materials Engineer may choose to perform a field volumetric mix design verification, as outlined 960.03.03.

APPENDIX "A"**INFORMATION OUTLINE FOR CONSULTANT / CONTRACTOR
MIX DESIGN REPORT****First Two/Three Pages of Design Submitted Shall Include the Following Mix Design Information:**

- X Date:
- X Laboratory Name:
 - Accreditation / Credentials (AMRL/UDOT approved)
- X Laboratory Technicians :
 - Credentials (UDOT certified)
- X UDOT Project Name & Number:
- X Nominal Gradation Size:
- X Number of Gyration:
 - N_{ini} , N_{des} , N_{max}
 - Corresponding ESAL Loading Range
- X Gyratory Compactor:
 - Brand / Model
- X Asphalt Binder:
 - PG Grade
 - Binder Source
 - Binder Specific Gravity
- X Measured Physical Properties
 - Design Mixing Temperature
 - Design Compaction Temperature
 - % Asphalt Binder Content @ N_{des}
 - % Absorbed Asphalt Binder @ N_{des}
 - % Effective Asphalt Binder @ N_{des}
 - % VMA @ N_{des} (Percent by Weight of Total Mix)
 - % VFA @ N_{des}
 - % Compaction @ N_{ini}
 - % Compaction @ N_{des}
 - % Compaction @ N_{max}
 - Dust to Asphalt Binder Ratio @ N_{des}
 - Maximum Specific Gravity @ N_{des}
 - % Lime Required
 - Bulk Specific Gravity G_{sb}
 - Maximum Specific Gravity G_{mm}
 - Target Gradation
- X Proof Testing - (Specification Dependent)
 - Hamburg Wheel Tracker
- X Aggregate
 - One Fracture Face Count
 - Two Fracture Face Count
 - Fine Aggregate Angularity
 - Flat & Elongated
 - L.A. Wear
 - Sand Equivalency (Pre-wet Method)
 - Natural Fines %
- X Additional Aggregate Source Information
 - Sodium Soundness
 - Unit Weight

- Clay Lumps & Friable Particles
- Plasticity Index
- X Gradation
 - Stockpile Percentages
 - Stockpile Specific Gravities & Absorptions
 - Lime Specific Gravity & Percentage & Supplier
 - Target Gradation
 - Plotted Gradation (0.45 power curve, control points, caution zone)
- X Gyratory Design
 - Calibrated Gyratory Angle
 - Calibrated Gyratory Pressure
 - Specimen Heights
- Reported Elsewhere in the Submittal:**
- X Trial Blend
 - Plotted on 0.45 Power Curve (Control Points, Caution Zone)
 - Stockpile Percentages
 - Stockpile Bulk Specific Gravities
 - Target Gradations
 - %AC, %G_{mm} @ N_{ini}, %G_{mm} @ N_{des}, %G_{mm} @ N_{max} (Sum. Table)
 - %AC, % Air Voids, %VMA, %VFA, Dust/AsphaltBinder, %G_{mm} @ N_{ini}, %G_{mm} @ N_{des}, %G_{mm} @ N_{max} (Summary Table @ N_{des})
 - Trial Blends
 - AC Percentage
 - Compaction Results
 - N_{ini} - N_{des} - N_{max}
 - Maximum Specific Gravity G_{mm}
 - Gyratory Equipment Printouts for all Blends
 - Specimen Heights
 - Pressure Applied
 - Gyrations Tables for Each Design AC Content
 - Number of Gyrations
 - Specimen Height
 - Estimated Bulk Density
 - Corrected Bulk Density
 - % of Maximum Specific Gravity

APPENDIX "B"EXAMPLE OF UDOT'S MIX DESIGN REVIEW REPORT

Memorandum

UTAH DEPARTMENT OF TRANSPORTATION

DATE:

TO:

Resident Engineer

FROM:

Region Materials Engineer

SUBJECT: Superpave Level I Mix Design Review Report

Project No.:

Project Name:

Contractor:

The contractor has indicated that their source of aggregate, Size _____ will be the _____ and the brand of PG asphalt cement will be _____. The asphalt concrete pavement mix will be produced at the _____ plant. The following recommendations are based on tests of the aggregate and bituminous mix.

The optimum AC recommendation is based on the Gyratory Mix Design Method. **N_{initial}** = _____, **N_{design}** = _____, and **N_{max}** = _____. The field specimen compaction temperature is _____ and the combined specific gravity (G_{sb}) of aggregates is _____. It is recommended that field Gyratory tests be done at production start, upon any mix adjustment, and at least once a week.

Asphalt Binder Grade: _____

Percentage Asphalt Binder: _____

Mixing Temperatures:

Minimum _____

Maximum _____

Minimum Compaction Temperature _____

Stockpile Blends:

CONTRACTOR'S DESIGN RESULTS:

Hydrated Lime % (Dry Wt. Agg.):

Job Mix Gradation

VMA:

Sieve

% Passing

1 inch

3/4 inch

Max. Specific Gravity (Rice):

1/2 inch

3/8 inch

Voids at N_{design}:

No. 4

No. 8

Pavement Analyzer Results:

No. 16

No. 30

Burn-off Correction Factor:

No. 50

Field:

No. 100

Region:

No. 200

Contractor's Superpave Mix Design Was: (See Box Checked Below)

Verified As Submitted

Verified With Conditions

Not Verified for Following Reasons

Comments/Conditions/Reasons: _____